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The effect of card games and computer games on learning of chemistry concepts

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Abstract

Chemistry has often been thought of as a dry and conceptual subject matter to grasp. Through the infusion of games, the learning of difficult chemistry concepts could be immensely improved. Therefore, the purpose of this study was to investigate the effect of teacher-made instructional card games and computer games on the learning of chemistry concepts in high school students. This was an experimental pretest / posttest study with a control group. The population consisted of female high school students majoring in math and science. The selected sample consisted of three groups of 35 students. The instrument was a teacher-made text of chemistry. Data were analyzed by ANCOVA. The results indicated that there was a significant difference between teacher-made card games and computer games with the traditional teaching method. However, there was no significant difference between teacher-made card games and computer games. Playing had a significant role in the learning of abstract concepts and the understanding of chemistry concepts was facilitated through creating excitement and joy, as well as interaction amongst students.

Keywords: Teacher-made game; Computer games; Instructional games; Learning; Chemistry concepts; Abstract concepts.

1. Introduction

Educational games are good for learning (Shaffer, et al., 2008; Kurt et al., 2005; Shaffer, 2004; Fasli, Michalakopoulos, 2006). This is a general declaration that may be challenged by some educators, but the beneficial effects of games on learning cannot be denied. Perhaps it is best to say that different types of games may be better suited for different learning goals than others, so the secret is to find the right educational games. An important reason for this misconception is that the findings of studies regarding the use of games for learning are inconclusive (Kreijns, Kirschner & Jochems, 2003; Prensky, 2001). This may be due to the fact that design and studying educational games is well thought-out as a multifaceted process. However, there is a general agreement amongst the educators that games are influential learning milieu (Royale, 2008; Squire, 2005).

A central issue in chemistry education is the relation between the real and molecular world. Many students studying the periodical tables in chemistry find difficulties in recalling the element's position in the periodic table and connecting the elements to their physical and chemical properties (Weiss, Knowlton, & Morrison, 2002). Students would better understand chemistry and use their understanding of difficult chemistry concepts if they were able to make deeper connections between concepts and realities. Educators ought to make science education more valuable and pertinent for a large and more diverse population (Wu, Krajcik, Soloway, 2001). In fact, modern

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society faces ever more multifaceted problems which in the teaching of science have a special magnitude. To tackle these problems, education needs to generate a new approach to present knowledge of science concepts, and the students' specific interests and needs must be taken into consideration (Feng, Spence & Pratt, 2007; Bunce, & Gable, 2002).

Nowadays every teacher, in every discipline, incorporates games into his or her teaching. Many chemistry instructors use different types of games to make learning chemistry more fun and interesting. The idea is that by participating in a game activity for learning, students engage their senses of touch, sight, and hearing. Boot et al. (2008) believe that such activities cater to a greater number of intelligences, such as audio, visual, linguistic, kinesthetic, interpersonal, and intrapersonal intelligence. Games are engaging and advantageous, and the students are likely to have greater recall of what they have learnt. Planning the games and implementing them in the classroom is not without its challenges. Critics imply that the lessons people learn from playing games as they presently exist are not always pleasing (Kim et al., 2009; Kozma, 2000), but even the most unsympathetic opponents agree that students learn something from playing games. Much effort needs to be put in to look up the appropriate games in the market or design new ones for a particular class of students. Teachers need to anticipate possible obstacles when the students are using games and facilitate activities well so that the game is effective and can achieve the lesson objectives (Tuzun, et al., 2008; Schank, Kozma, 2002).

Despite the unsurpassed intentions of educators in Iran, the effort to incorporate games into the national curriculum has often been futile. Many teachers think about games as a waste of time. Teachers often do not succeed to accomplish the educational objectives contained in the curriculum, and major concerns are the lack of time to cover the syllabus and fear of not preparing students sufficiently for the final examinations. For them, games make the learning process too long and focused on the wrong objectives. However, our students are no longer the people that our educational arrangement was intended for. Their early exposure to technological devices in their everyday lives has made them prefer different forms of interacting with contents. Integrating games in the course outline is just recently receiving an increasing amount of attention in learning circles in Iran.

Riyahi Chelvani (2004) in his investigation of teaching basic terms to non-Persian speaking children found that games speed up the learning process, create interaction, and motivation to learn. Salman (2001) found that games are instrumental in the development of the mind. He also showed that there was no significant difference between the sexes. Naderi (2002) studied 20 language games and their effect on the improvement of learning English. His findings revealed that games are effective in learning English in middle schools. Kebritchi et al. (2010) found significant improvement of mathematic achievement in students who worked with computer games. Rauf (2002) claimed that students process information better by games and learn and understand concepts much easier. There is not sufficient work in this area in Iran.

Cordova & Lepper (1996) found that providing concrete contextualization's for games enhanced student motivation and learning outcomes significantly. The students became more deeply involved in the activities and attempted to use more complex operations, and as a result, they learned more. Marzano (2007) has been involved in over 60 studies on using games in the classroom and their effect on student accomplishment which showed a 20 percentile increase in their achievement. Several studies have concluded that games had positive effects on problem solving, achievement, and interest and engagement in task learning (Kim, Park, & Baek, 2009; Tuzun et al., 2008; Wideman, Owston, Brown, Kushnirk, Pitts, et al. 2007; Oyen and Bebeko, 1996; Robertson & Howell, 2008). This study hypothesized that teacher-made instructional card games and computer games have a positive effect on the learning of chemistry concepts. The study attempted to test three hypotheses in this regard.

2. Methodology

This was an experimental study. It was conducted with a controlled pretest / posttest design to analyze the effect of teacher-made card games and computer games on the learning of chemistry concepts at high school level. All courses applied to the experimental and control groups were conducted by the researchers.

2.1. Hypothesis

Three hypotheses were tested in the investigation:

1. There is a significant difference between students' learning of chemistry concepts via instructional card games and students' learning by traditional methods.
2. There is a significant difference between students' learning of chemistry concepts via computer games and students' learning by traditional method.
3. There is a significant difference between students' learning of chemistry concepts via instructional card games and students' learning by computer games.

2.2. Participants

The study was carried out on 105 high school students in Tehran (5th district). Three classes were randomly chosen as two experimental groups and a control group. Each consisted of 35 female students. Their age ranged from 16 to 17 years old.

2.3. Instruments

Two instructional games were developed for this study. The first game was a researcher-made card game regarding the naming of chemical compounds. The second game was a commercially produced computer game manipulated with minor changes by researchers on the same subject. All students received three weeks of teaching.

3. Finding

This study followed a pretest / posttest, experimental design. Before the intervention, a researcher-made chemistry exam was administered to all participants in the three groups. Students were randomly assigned to two experimental groups and a control group. Data collected from this study consists of students' pretest and posttest scores. The mean and standard deviation of the pretests and posttests for all three groups are presented in Table 1. The results revealed that mean scores of the experimental groups increased, while for the control group, the total score did not show significant gains from pretest to posttest. The results demonstrated that treatment in the experimental groups significantly improved students' learning.

Table 1. Students pre- and posttest learning in the experimental and control groups

Groups	pre-Test Mean	SD	Post-Test Mean	SD
Control Group	0.15	0.32	8.74	3.34
Experimental Group 1	0.20	0.40	11.25	3.01
Experimental Group 2	0.17	0.38	12.14	3.67

Analysis of the data shows that $F(2,101)=9.4$ & $P<0.001$. There is a significant difference between the posttest scores for learning in the experimental groups and the control group. Hence, hypotheses 1 & 2 were not refuted. Both treatment methods (learning by card games and computer games) were more effective for naming chemical compounds than the control method. The result of Bonferroni Correction showed no significant difference between learning by teacher-made card games and computer games. Therefore, hypothesis 3 was rejected.

Table 2. One-way ANCOVA on learning between the experimental and control groups

Sum of Squares	df	MS	F	p	Bonferroni Correction
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Intercept	9992.42	1	9992.42	880.42	0.00*	3<2=1
Pre-test	1.35	1	1.35	0.11	0.73*	
Group	213.61	2	106.81	9.41	0.00*	
Error	1146.3	101	11.35			

Note. * for $p < .0005$

4. Conclusion

Findings of this study demonstrate that the teacher-made instructional card game and computer game are effective tools for learning of chemistry concepts. Properly used, games can be a useful tool in the learning of chemistry concepts (Gee, 2005; Bolinggi, 2009; Chua, 2005). Findings from this study have the prospective to offer chemistry teachers and educators insight in helping students create intangible associations between different topics and promote meaningful learning of chemistry concepts. The results demonstrated that playing games endorsed active learning, concentration, and utilization of trial and error. A well developed educational game, in addition to its potential for learning and entertainment, can promote interaction between peers. Traditional classrooms are inactive. Findings of this study indicate that games are influential in the learning of abstract concepts, are enjoyable, and allow the students to benefit from the experience of other classmates.

Chemistry instructors could consider integrating games into their course plans. Games have the potential to change the landscape of education as it exists. Games could move our system of education beyond the traditional disciplines, and towards a new model of meaningful learning. Games in the classroom would definitely make students more engaged in their learning. Success in this area depends on how games are used. Further research in the field of games and learning must be conducted and the most effective roles for teachers in these learning systems should be identified (Barsalou, 1999; Sisovic & Bojovic, 2000). The full potential of educational games has not been fully discovered.

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